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<p>During the second year of this research program, work has continued on multi-instrument experiments investigating the effects of the large-scale convection electric field in the auroral and mid-latitude ionosphere. A radar-satellite study of electric field latitude structure during the February 8-9, 1986 great magnetic storm was completed (Yeh et al., 1991) and has provided an excellent example of the application of multi-instrument techniques to the investigation of magnetosphere-ionosphere coupling problems. Studies of the high-latitude boundary between auroral and polar cap latitudes have emphasized convection and ionospheric plasma structure near the dayside cusp and the transport of ionospheric plasma into the polar cap during storms. Meso-scale resolution electric field structure was addressed in a multi-instrument study involving the Canadian BARS radar facility and the Millstone Hill incoherent scatter radar (Moorcroft et al., 1991).</p>					
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RADAR-SATELLITE Studies of the HIGH-LATITUDE Ionosphere

in Year Ending

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SCIENTIFIC ACCOMPLISHMENTS: SECOND YEAR

During the second year of this research program, work has continued on multi-instrument experiments investigating the effects of the large-scale convection electric field in the auroral and mid-latitude ionosphere. A radar-satellite study of electric field latitude structure during the February 8-9, 1986 great magnetic storm was completed (Yeh et al., 1991) and has provided an excellent example of the application of multi-instrument techniques to the investigation of magnetosphere-ionosphere coupling problems. Studies of the high-latitude boundary between auroral and polar cap latitudes have emphasized convection and ionospheric plasma structure near the dayside cusp and the transport of ionospheric plasma into the polar cap during storms. Meso-scale resolution electric field structure was addressed in a multi-instrument study involving the Canadian BARS radar facility and the Millstone Hill incoherent scatter radar (Moorcroft et al., 1991).

A). Storm-Time Convection Electric Field

During the peak of the February 8-9, 1986 magnetic storm, the Millstone Hill radar was in the evening local time sector (16-22 MLT). Radar observations, reported by Yeh et al. [1991], indicate that high speed ($>1000 \text{ m s}^{-1}$) westward ion flow penetrated deeply below 50° invariant latitude (Λ) and persisted for 6 hours between 2100 UT on February 8, and 0300 UT on February 9. A double-peaked ion convection feature was pronounced throughout the period and the separation in the dual maxima ranged from 4° to 10° . Using simultaneous particle (30 eV - 30 keV) precipitation data from the DMSP F6 and F7 satellites, we find the high-latitude ion drift peak to coincide with the boundary plasma sheet/central plasma sheet transition in the high ionospheric conductivity (>15 mhos) region. The low-latitude ion drift peak lay between the equatorward edges of the electron and soft ($< 1 \text{ keV}$) ion precipitation in the low conductivity region (~ 1 mho). The low-latitude ion drift peak is the low-altitude signature of the electric field shielding effect associated with ring current penetration into the outer layer of the storm time plasmasphere. Unlike the transient and localized subauroral ion drifts (SAID), the intense westward ion drifts developed in response to heavy ion ring current shielding during a great magnetic storm can decouple from the high latitude electric field and penetrate to very low-latitudes, and persist for long durations in the dusk and early afternoon MLT sectors. The resultant westward ion convection can have profound effects on the transport of dayside F-region plasma toward the polar cap and on the generation of heavy ion outflows at mid-latitudes.

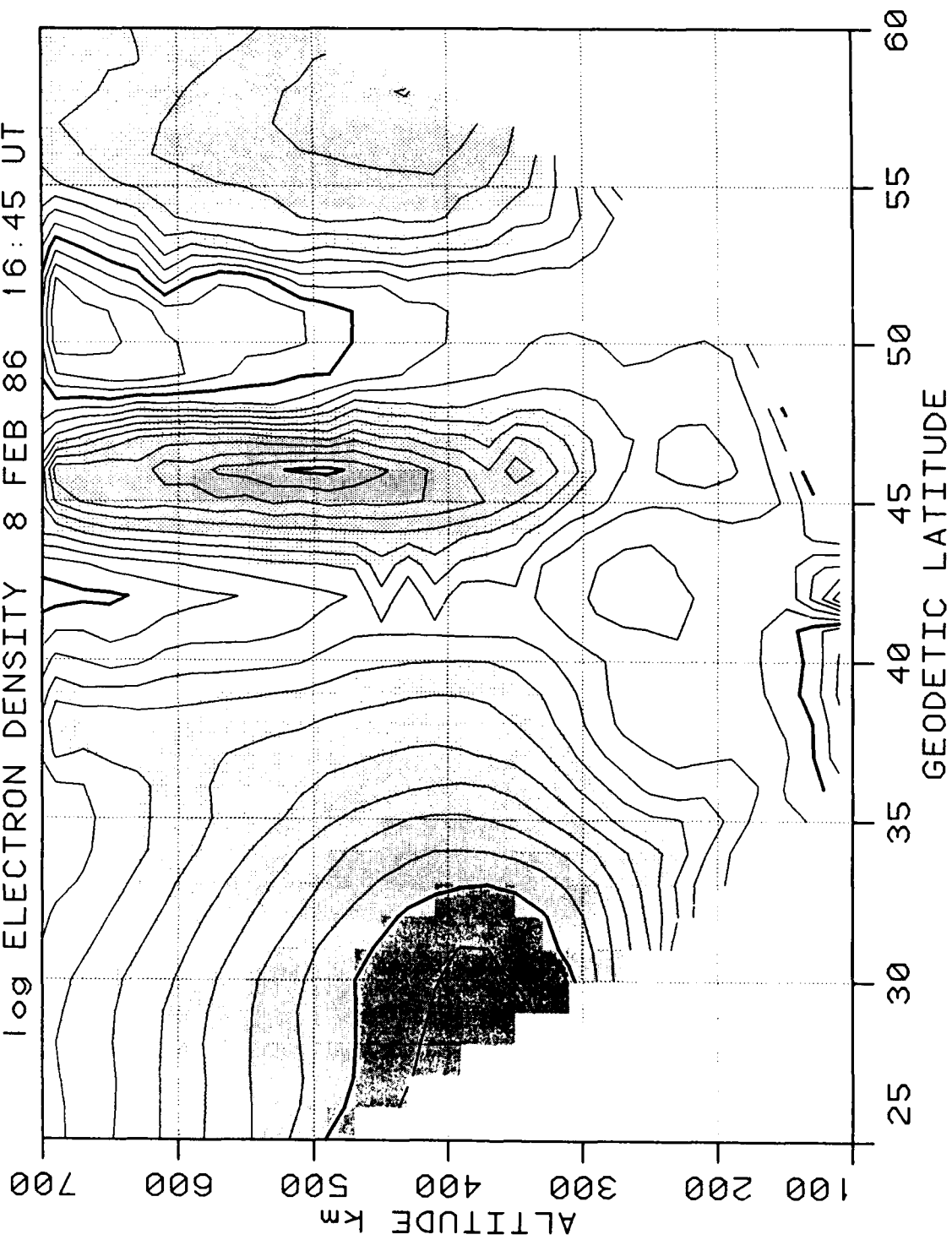
B). Studies of the Cusp and Polar Cap Boundary

Azimuth scanning experiments with incoherent scatter radars can produce two-dimensional maps of plasma characteristics and electric fields which span the auroral oval - polar cap boundary in the vicinity of the dayside cusp and cleft. The Atmospheric Sciences group at Millstone Hill has pursued a series of investigations of this important region using combined radar and satellite data sets and this work is continuing with a study of plasma transport into the polar cap from the low latitude F region. Initial results suggest that this mechanism constitutes an important source for the polar cap ionization patches which lead to irregularity growth and intense polar scintillations. Figure 1 presents a radar elevation scan which reveals dramatic ionospheric density structure in the vicinity of the noontime cleft during an intense magnetic storm. Observations of the convection electric field associated with this region show that such discrete, intense density enhancements are transported rapidly poleward into the polar cap. A paper is in preparation describing this effect.

C). Meso-Scale Structure of the Electric Field

Simultaneous data sets obtained with the Millstone Hill incoherent scatter radar and the twin coherent auroral radars at the Canadian BARS facility have been analyzed to interrelate the two measurement techniques and to facilitate the interpretation of medium-scale electric field structure and variability within the scanning field of view of the Millstone Hill radar (Moorcroft et al., 1991). Work in progress will extend this multi-instrument technique to provide rapid (60 sec) analysis of the intense mid-latitude electric field structures (SAIDs) which often occur in the overlapping fields of view of these two radar facilities.

log ELECTRON DENSITY 8 FEB 86 16:45 UT



RESEARCH PAPERS GENERATED UNDER AFOSR SUPPORT: FY '91

Yeh, H.-C., J. C. Foster, F. J. Rich, and W. Swider, Storm Time Electric Field Penetration Observed at Mid-latitude, *J. Geophys. Res.*, 96, 12075-12090, 1991.

Moorcroft, D. R., M. Loranc, J.-P. St-Maurice, and J. C. Foster, Comparison of Bistatic Auroral Radar System Observations with Velocities Obtained using the Millstone Hill Incoherent Scatter Radar, *J. Geophys. Res.*, submitted, 1991.

TRAVEL SUPPORTED BY AFOSR PROJECT

June, 1991, London, Ontario.: J. Foster to attend 1991 North American URSI Meeting.

Professional Personnel

Dr. J. C. Foster - Principal Investigator
Dr. J. M. Holt - Senior Research Scientist
Dr. H. C. Yeh - Research Scientist
Ms. C.-N. Lue (applications programming)

SCIENTIFIC INTERACTIONS

1. Spoken Papers:

"How wide is the Cusp? - Radar Observations", (J. Foster), GEM Workshop, Weston, Mass. Oct., 1990 (invited).

"Scanning Radar Observations of Ionospheric Convection at the Auroral Oval - Polar Cap Boundary", (J. Foster), 1991 North American URSI Meeting, London, Ont., June, 1991 (invited).

2. Consultative and Advisory Functions:

- | | |
|---------------------------------|--|
| a) QUIMMS overflight campaign. | AF/AFGL personnel: D. Hunton. |
| b) CIRRIIS overflight campaign. | AF/AFGL personnel: J. Wise, R. Nadile |
| c) CRRES data exchange. | AF/AFGL personnel: E. Weber, H. Singer |
| d) Ionospheric Tomography | AF/AFGL personnel: J. Klobuchar |